WHAT IS CLAIMED IS:

1. A method of distributing power from an input source to a load, where the load may vary over a normal operating range, comprising:

using a first regulator at a first location to convert power from the input source at a source voltage, V_{source}, and deliver a controlled DC voltage, V_f, to a factorized bus;

using the factorized bus to carry power from the first regulator to a remote location separated by a distance from the first location;

using a voltage transformation module ("VTM") at the remote location to convert power, via a transformer, from the factorized bus at an input voltage V_{in}, essentially equal to the voltage delivered to the bus, V_f, to a DC output voltage, V_{out}; and

using in the VTM an essentially constant voltage gain, $K = V_{out} / V_{in}$, at a load current;

wherein the VTM has an output resistance, R_{out}; and

wherein the load is supplied with a voltage, V_{load}, essentially equal to the output voltage of the VTM, V_{out}, which is regulated by the first regulator using the factorized bus.

2. A method of distributing power from an input source to a load, where the load may vary over a normal operating range, comprising:

using a first regulator at a first location to convert power from the input source at a source voltage, V_{source}, and deliver a controlled DC voltage, V_f, to a factorized bus;

using the factorized bus to carry power from the first regulator to a remote location separated by a distance from the first location;

using a voltage transformation module ("VTM") at the remote location to convert power from the factorized bus and deliver a load voltage, V_{load}, the VTM having an input for receiving an input voltage, V_{in}, essentially equal to the voltage delivered to the bus, V_f, and an output for delivering an output voltage, V_{out}, essentially equal to the load voltage, V_{load}, and an output resistance, R_{out};

using a transformer in the power train of the VTM;

using in the VTM an essentially constant voltage gain, $K = V_{out} / V_{in}$, at a load current;

the VTM having two or more power switches and using a power conversion duty cycle greater than 80%.

3. A method of distributing power from an input source to a load, where the load may vary over a normal operating range, comprising:

using a first regulator at a first location to convert power from the input source at a source voltage, V_{source}, and deliver a controlled DC voltage, V_f, to a factorized bus;

using the factorized bus to carry power from the first regulator to a remote location separated by a distance from the first location;

using a voltage transformation module ("VTM") at the remote location to convert power from the factorized bus and deliver a load voltage, V_{load}, the VTM having two or more primary switches connected to drive a transformer, an input for receiving an input voltage, V_{in}, essentially equal to the bus voltage, V_f, and an output for delivering an output voltage, V_{out}, essentially equal to the load voltage, V_{load}; and

operating the primary switches in a series of converter operating cycles, each converter operating cycle characterized by

(a) two power transfer intervals of essentially equal duration, during which one or more of the primary switches are ON and power is transferred from the input to the output via the transformer, and

(b) two energy-recycling intervals during which the primary switches are OFF;

wherein the load voltage, V_{load}, is regulated by the first regulator using the factorized bus.

4. A method of providing a power density greater than 200 Watts/cubic-inch in point-of-load converters for efficiently supplying a regulated DC voltage, V_{load}, to a load, where the load may vary over a normal operating range, from an input source, the method comprising:

factorizing away from the point-of-load a power-conversion function of voltage regulation by using a first regulator to convert power from the input source to a controlled voltage, V_f, delivered to a factorized bus;

localizing at the point-of-load a function of DC voltage transformation by converting the factorized bus voltage at the point-of-load, V_{in}, to an output voltage, V_{out}, essentially equal to V_{load}, with a voltage transformation module ("VTM");

adapting the VTM to operate at or above 500 KHz, to convert power via a transformer, and to provide an essentially constant DC voltage gain, $K = V_{out} / V_{in}$, at a load current, and

regulating the load voltage, V_{load}, by controlling the voltage of the factorized bus, V_f.

5. A method for providing scalable electric power conversion capability in which power is converted from an input source and delivered to a load at a regulated DC output voltage, where the load may vary over a normal operating range, the method comprising:

using a first regulator to convert power from the input source at a source voltage, V_{source}, to a controlled DC voltage, V_f, delivered to a factorized bus;

operating two or more voltage transformation modules ("VTMs), each comprising a transformer and an output resistance R_{out}, in parallel to convert power, via the transformers, from an input voltage, V_{in}, essentially equal to the factorized bus voltage, V_f, to a DC output voltage, V_{out};

using an essentially constant voltage gain, $K = V_{out}/V_{in}$, at a load current, in each of the VTMs;

wherein the power provided to the load is shared in inverse proportion to the output resistance by each of the VTMs; and

the output voltage provided to the load, V_{load}, is essentially equal to the output voltage of each of the VTMs, V_{out}, and is regulated by the first regulator using the factorized bus.

6. The method of claim 1 further comprising

controlling the controlled bus voltage, V_f, using a feedback signal derived from the load voltage, V_{load}.

7. The method of claim 1 further comprising using the VTM transformer to galvanically isolate the load from the factorized bus.

8. The method of claim 1 further comprising a plurality of VTMs connected to the factorized bus.

9. The method of claim 1 further comprising a plurality of VTMs connected to the factorized bus and operating in parallel to share the power delivered to the load.

10. The method of claim 9 wherein the VTMs are distributed over a multiplicity of locations.

11. The method of claim 1 further comprising

programming the load voltage, V_{load}, to a selected value by using a feedback signal to control the factorized bus voltage, V_f.

12. The method of claim 1 further comprising

using an output switch in series with the output of the VTM to selectively connect the VTM to the load; and

operating the output switch to protect the load from a fault within the VTM;

wherein the load voltage is protected from VTM faults.

13. The method of claim 1 further comprising

using an input switch in series with the input of the VTM to selectively connect the VTM to the factorized bus; and

operating the input switch to protect the factorized bus from a fault within the VTM;

wherein the factorized bus voltage is protected from VTM faults.

14. The method of claim 1 further comprising

using an input device in series with the input of the VTM to selectively connect the VTM to the factorized bus; and

operating the input device to limit the voltage applied to the VTM;

wherein the VTM is protected from the factorized bus voltage.

15. The method of claim 1 further comprising:

using a front end converter at a first location to convert power from the input source and deliver a DC voltage, V_{bus}, to a first bus;

using a power regulator module ("PRM") at a second location, separated from the first location by a distance, to convert the DC voltage from the first bus and deliver the controlled DC voltage, V_f, to the factorized bus;

wherein the first regulator comprises the front end converter and the PRM.

16. The method of claim 15 further comprising controlling the PRM to adjust the factorized bus voltage, V_f, by using a feedback signal derived from the load voltage, V_{load}.

17. The method of claim 3 wherein the VTM uses a power conversion duty cycle greater than 80 per cent over the normal operating range.

18. A method of distributing electrical power in a vehicle comprising the method of claim 1 wherein:

the first regulator is located near a source of power in the vehicle;

the factorized bus distributes the controlled DC voltage, V_f, to a plurality of locations throughout the vehicle;

a plurality of VTMs are distributed throughout the vehicle to provide power to loads distributed throughout the vehicle. .

19. Apparatus for distributing power from an input source to a load, where the load may vary over a normal operating range, comprising:

a first regulator at a first location having a first input and a first output, the first regulator having circuitry adapted to convert power from the input source at a source voltage, V_{source}, and deliver a controlled DC voltage, V_f, to the first output;

a factorized bus connected to the first output of the first regulator and extending to a remote location separated by a distance from the first location;

a voltage transformation module ("VTM") at the remote location having circuitry, including a transformer, adapted to convert power from an input voltage, V_{in}, essentially equal to the voltage delivered to the bus, V_f, to a DC output voltage, V_{out};

the VTM having an essentially constant voltage gain, $K = V_{out} / V_{in}$, at a load current and having an output resistance, R_{out};

wherein the load is supplied with a voltage, V_{load}, essentially equal to the output voltage, V_{out}, and regulated by the first regulator using the factorized bus.

20. Apparatus for distributing power from an input source to a load, where the load may vary over a normal operating range, comprising:

a first regulator at a first location having a first input and a first output, the first regulator having circuitry adapted to convert power from the input source at a source voltage, V_{source}, and deliver a controlled DC voltage, V_f, to the first output;

a factorized bus connected to the first output of the first regulator and extending to a remote location separated by a distance from the first location;

a voltage transformation module ("VTM") at the remote location having circuitry, including a transformer, adapted to convert power from the factorized bus and deliver a load voltage, V_{load}, the VTM having an input for receiving an input voltage, V_{in}, essentially equal to the voltage delivered to the bus, an output for delivering an output voltage, V_{out}, essentially equal to the load voltage, V_{load}, an essentially constant voltage gain, $K = V_{out} / V_{in}$, at a load current, and an output resistance, R_{out};

the VTM further comprising two or more power switches and a power conversion duty cycle greater than 80% over the normal operating range.

21. Apparatus for distributing power from an input source to a load, where the load may vary over a normal operating range, comprising:

a first regulator at a first location having a first input and a first output, the first regulator having circuitry adapted to convert power from the input source at a source voltage, V_{source}, and deliver a controlled DC voltage, V_f, to the first output;

a factorized bus connected to the first output of the first regulator and extending to a remote location separated by a distance from the first location;

a voltage transformation module ("VTM") at the remote location and having an input for receiving a DC input voltage, V_{in}, essentially equal to the voltage delivered to the bus, V_f, two or more primary switches connected to drive a transformer with power received from the input, an output for delivering a DC output voltage, V_{out}, an output resistance, R_{out}, and a switch controller adapted to operate the primary switches in a series of converter operating cycles, each converter operating cycle characterized by

(a) two power transfer intervals of essentially equal duration, during which one or more of the primary switches are ON and power is transferred from the input to the output via the transformer,

(b) two energy-recycling intervals during which the primary switches are OFF;

wherein the load is supplied with a voltage, V_{load}, essentially equal to the output voltage, V_{out}, and regulated by the first regulator using the factorized bus.

22. Apparatus for converting power at a point-of-load from a factorized bus driven by a source of controlled DC voltage, V_f, for delivering a regulated DC voltage, V_{load}, to a load where the load may vary over a normal operating range, the apparatus comprising:

a voltage transformation module ("VTM") having an enclosure for housing power conversion circuitry, an input terminal, and an output terminal;

the power conversion circuitry comprising:

an input connected to the input terminal and adapted to receive a DC input voltage, V_{in}, essentially equal to V_f;

an output connected to the output terminal and adapted to deliver a DC output voltage, V_{out}, essentially equal to V_{load};

a transformer;

two or more primary switches connected to drive the transformer with power received from the input; and

a controller adapted to operate the primary switches in a series of converter operating cycles, each converter operating cycle characterized by

(a) two power transfer intervals of essentially equal duration during which one or more of the primary switches are ON and power is transferred from the input to the output via the transformer,

(b) two energy-recycling intervals during which the primary switches are OFF; and

(c) a period less than 2 micro seconds;

wherein the VTM has a power density greater than 250 Watts/cubic-inch, an essentially constant DC voltage gain, $K = V_{out}/V_{in}$, at a load current, and an output resistance, R_{out}, and regulates the load voltage, V_{load}, as a fraction, K, of the factorized bus voltage, V_f.

23. Apparatus for providing scalable electric power conversion capability in which power is converted from a factorized bus driven by a voltage source of controlled DC voltage, V_f, and delivered to a load at a regulated DC output voltage, V_{load}, where the load may vary over a normal operating range, the apparatus comprising:

two or more voltage transformation modules ("VTMs") connected in parallel, each VTM having

(a) an input adapted to receive a DC input voltage, V_{in}, essentially equal to V_f;

(b) an output adapted to deliver an output voltage, V_{out}, essentially equal to V_{load};

(c) a transformer;

(d) two or more primary switches connected to drive the transformer with power received from the input; and

(e) a controller operating the primary switches in a series of converter operating cycles;

(f) an essentially constant voltage gain $K = V_{out}/V_{in}$ at a load current; and

(g) an output resistance, R_{out};

wherein the power delivered to the load is shared by each VTM in inverse proportion to the output resistance of each VTM; and

the output voltage supplied to the load, V_{load}, is essentially equal to the output voltage, V_{out}, of each of the VTMs and is regulated by the factorized bus voltage V_f.

24. The apparatus of claim 19 further comprising a feedback controller for adjusting the voltage, V_f, of the factorized bus using a feedback signal derived from the load voltage, V_{load}.

25. The apparatus of claim 19 wherein the VTM further comprises galvanic isolation from the input to the output.

26. The apparatus of claim 19 further comprising a plurality of VTMs connected to the factorized bus.

27. The apparatus of claim 19 further comprising a plurality of VTMs connected to the factorized bus and operating in parallel to share the power delivered to the load.

28. The apparatus of claim 26 wherein the VTMs are distributed over a multiplicity of locations.

29. The apparatus of claim 19 further comprising an output controller for adjusting the voltage, V_f, of the factorized bus to program the load voltage, V_{load}, to a selected value.

30. The apparatus of claim 19 further comprising

an output switch connected in series between the output of the VTM and the load; and

an output switch controller adapted to detect a normal state and a fault state of the VTM and operate the output switch in its ON and OFF states;

wherein the VTM is disconnected from the load in the event of a fault state.

31. The apparatus of claim 19 further comprising

an input switch connected in series between the input of the VTM and the load; and

an input switch controller adapted to detect a normal state and a fault state of the VTM and operate the input switch in its ON and OFF states;

wherein the VTM is disconnected from the factorized bus in the event of a fault state.

32. The apparatus of of claim 19 further comprising

an input device connected in series between the input of the VTM and the load; and

an input switch controller adapted to detect the factorized bus voltage and operate the input device to limit the voltage applied to the VTM;

wherein the VTM is protected from the factorized bus voltage.

33. The apparatus of claim 22 wherein the VTM operates at a greater than 90 per cent power conversion duty cycle over the normal operating range.

34. The apparatus of claim 19 wherein

the first regulator further comprises a front end converter and a power regulator module ("PRM");

the front end converter being situated at a first location and having an input connected to receive power from the input source, having an output connected to a first bus, and being adapted to convert power from the input source and deliver a DC voltage to the first bus; and

the PRM being located at a second location and having an input connected to the first bus, having an output connected to the factorized bus, and being adapted to convert power from the first bus and deliver the controlled DC voltage, V_f, to the factorized bus.

35. The apparatus of claim 30 further comprising a feedback controller for adjusting the voltage, V_f, of the factorized bus using a feedback signal derived from the load voltage, V_{load}, and applied to the PRM.

36. The apparatus of claim 19 wherein:

the VTM further comprises secondary switches to rectify power from the transformer; and

the secondary switches are turned ON and OFF essentially at times of zero voltage.

37. The apparatus of claim 19 wherein the VTM further comprises secondary switches to rectify power from the transformer; and

the secondary switches are turned ON and OFF essentially at times of zero current.

38. The apparatus of claim 19 further comprising a feedback controller for increasing the output resistance, R_{out} of the VTM using a feedback signal related to the output current, I_{out} of the VTM.

39. The apparatus of claim 19 further comprising a feedback controller for decreasing the output resistance, R_{out} of the VTM using a feedback signal related to the output current, I_{out} of the VTM.

40. The method of claim 1 or apparatus of claim 19 wherein the first regulator comprises a buck-boost switching regulator.

41. The method of claim 1 or apparatus of claim 19 wherein the first regulator comprises a buck-boost ZVS regulator.

42. The method of claim 15 or apparatus of claim 34 wherein the PRM comprises a buck-boost switching regulator.

43. The method of claim 15 or apparatus of claim 34 wherein the PRM comprises a buck-boost ZVS regulator.